



March Meeting Summary

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FAA Public Meeting
Cessna 400 Series Wing Spar Safety Concern
Downtown Kansas City Marriott
August 18, 2004

March Meeting Summary



- ① FAA and proprietary information
- ① FAA summary of previously proposed Airworthiness Directives
- ① Manufacturer perspective (Cessna)
- ① Operator perspective (Cape Air)
- ① FAA Data Evaluation

March Meeting Summary (con't)



① FAA related Issues

- ① Aging rule, related Research & Development
- ① Supplement Inspection Documents (SID) & maintenance programs
- ① Expectations for AMOCs, AD process

① Public Comments, Questions

AD Process – Unsafe Condition



- ① **14CFR Part 39 is the legal framework for the FAA's ADs system**
- ① **14CFR Part 39 requires for an AD to be issued:**
 - ① FAA has to find that an unsafe condition exists in the product
 - ① The unsafe condition is likely to exist or develop in other products of the same type design
- ① **AD Standard Procedure:**
 - ① Issue a Noticed of Proposed Rule Making
 - ① Obtain public comments on the proposed rule
 - ① Evaluate those comments
 - ① Make a decision on proceeding with the Final Rule AD



Existing ADs

- ① AD 79-10-15 R2: 401/A/B, 402A/B, 411/A
 - ① Requires repetitive inspections of the front lower wing spar cap every 400 hrs
 - ① Surface eddy current to detect cracks under skin
 - ① Requires repetitive inspections of the wing attach fittings every 1000 hrs
 - ① Surface eddy current to detect cracks at two locations
- ① AD 2000-23-01: 402C
 - ① Requires repetitive inspections of lower wing spar cap every 110 hrs for 402C only
 - ① Visual inspection of front, aft, and auxiliary wing spars for cracks

Proposed ADs - Withdrawn



- ❶ Docket: 2002-CE-05-AD
- ❶ Unsafe condition: Fatigue cracks in wing spars require wing spar cap repair or replacement
- ❶ Proposed Action:
 - ❶ Terminates wing spar inspections of AD 79-10-15 R2
 - ❶ Maintain Wing attach fitting inspections of AD 79-10-15 R2 (Area "A" and "B")
 - ❶ Requires Cessna Service Bulletin wing spar inspections
 - ❶ Requires installation of Cessna Service Kits
 - ❶ Requires repetitive inspections of the installed strap

Proposed ADs - Withdrawn



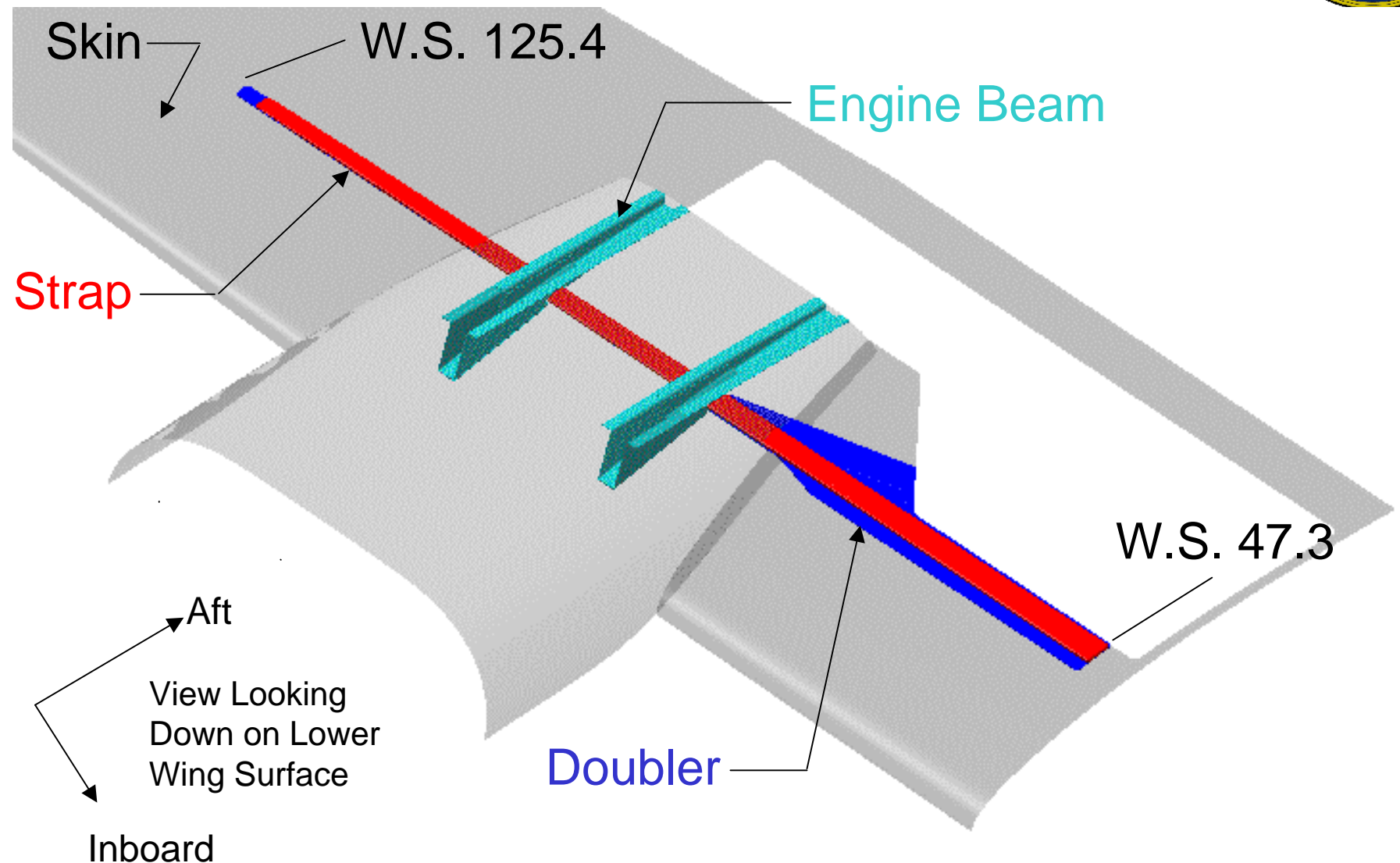
- ① Docket: 2002-CE-57-AD
- ① Unsafe condition: Fatigue cracks in wing spars require wing spar cap repair or replacement
- ① Proposed Action:
 - ① Terminates wing spar inspections of AD 2000-23-01
 - ① Requires Cessna Service Bulletin wing spar inspections
 - ① Requires installation of Cessna Service Kits



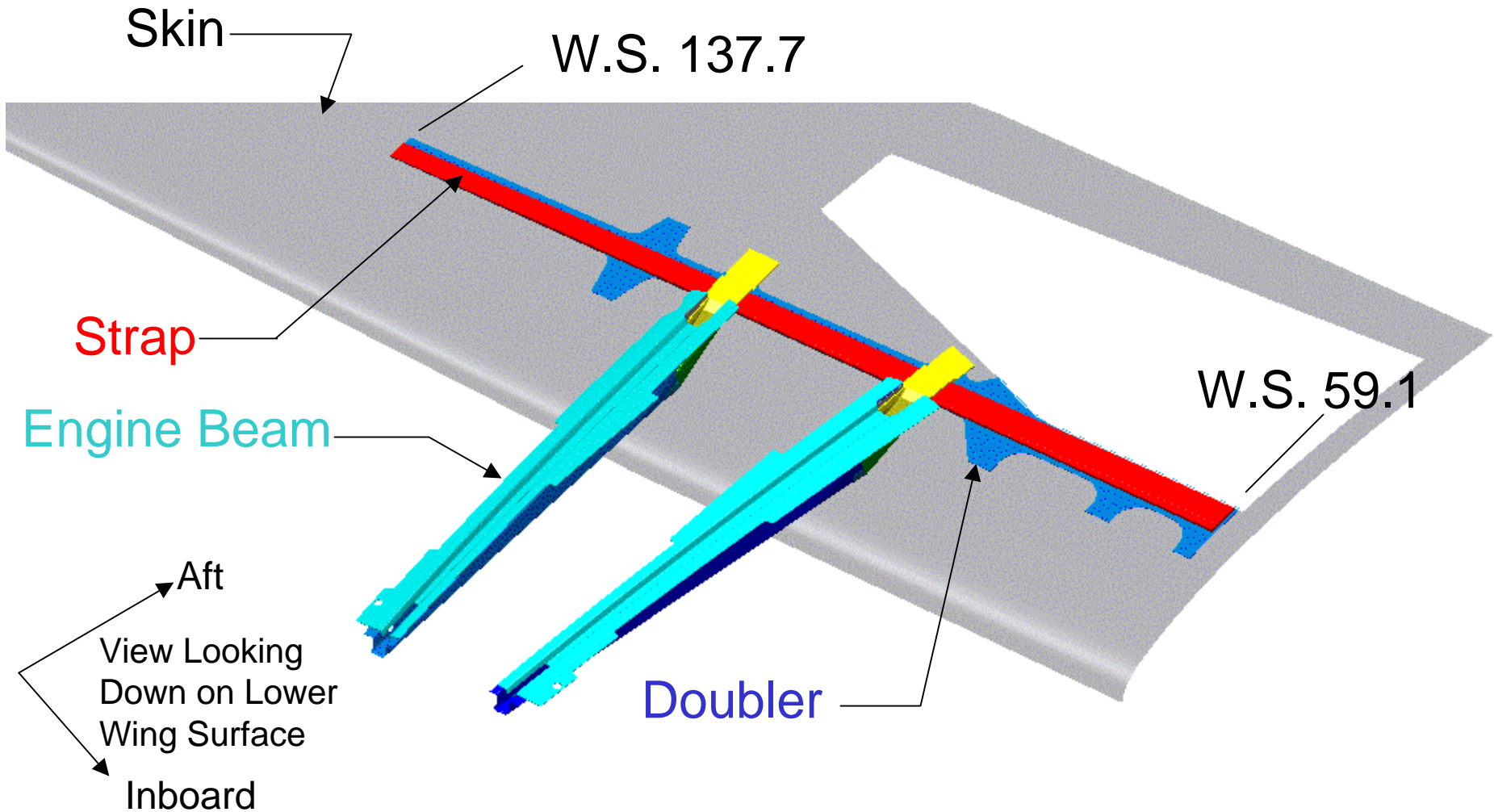
Previously Proposed Compliance

Model	Installation threshold	Inspection to be Terminated	Strap Inspection Threshold
401, 401A, 401B, 402, 402A, 402B	6,500 flight hrs.	AD 79-10-15R2 (Lwr spar cap only)	19,900 flight hours after installation
411, 411A	5,500 flight hrs.	AD 79-10-15R2 (Lwr spar cap only)	19,900 flight hours after installation
402C	14,500 flight hrs.	AD 2000-23-01	(TBD w/ future AD)
414A (units 1-200)	8,500 flight hrs.	None	(TBD w/ future AD)
414A (Units 201++)	14,500 flight hrs.	None	(TBD w/ future AD)

Model 401/402/411 Wing Strap Layout



Model 402C/414A Wing Strap Layout



Cessna Presentation Summary

March 2004 Meeting



- ① **Airframe Design History**
- ① **Fatigue – General Concepts**
- ① **Analysis**
- ① **Fatigue Tests**
- ① **Field History**
- ① **NDI Options**
- ① **Wing Modification Options**
- ① **Conclusion**

Note: FAA Website or Formal Transcript

Cessna Presentation Conclusions

March 2004 Meeting



- ❶ Currently mandated inspection methods are inadequate to detect fatigue cracks in the wing spar before the wing can no longer carry the required loads
- ❶ This conclusion is based on analyses, testing and field data
- ❶ The wing spar reinforcement strap is necessary to address the continued airworthiness of these airplanes
- ❶ Failure to install the reinforcement strap or some other alternate means of compliance to achieve similar results, will increase the likelihood that a fatal accident will occur due to spar cap cracking

Cape Air Presentation Summary

March 2004 Meeting



- ① 13 A/C (26 wings) Inspected/Tested (as of 3/04)
 - ① 9 Aircraft (18 wings) Modified
 - ① 5 Lower Front Spar Caps Replaced due to defects (4 field, 1 factory induced)
 - ① 6 Lower Front Spar Caps repaired due to field induced defects
 - ① Labor Hours: 400-500 (MEB02-5 R1 calls for 485) for experienced mechanic with no additional repairs
 - ① 300-400 additional labor hours to change spar cap

Cape Air Presentation Conclusions

March 2004 Meeting



- ① Modification needed (system safety approach)
- ① Concerns
 - ① Industry Backlog due to proposed 12 month/500hr compliance
 - ① Quality control of field repairs and training of mechanics
 - ① Capabilities/Capacity of repair facilities
 - ① Time delays based on engineering support
- ① Possible Solutions
 - ① Analyze industry capabilities before issuing AD
 - ① Phase in compliance schedule
 - ① Prepare for projected engineering support
 - ① Oversight and training for repair facilities



FAA Data Evaluation

Bob Eastin

**Chief Scientist, Technical Advisor
Fatigue & Damage Tolerance**

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Overview



- Fatigue
- Fatigue Management
- Cessna 400 Wing Spar Cap Findings
- Inspection Considerations
- Wing Structural Integrity Issues
- Proposed Corrective Action

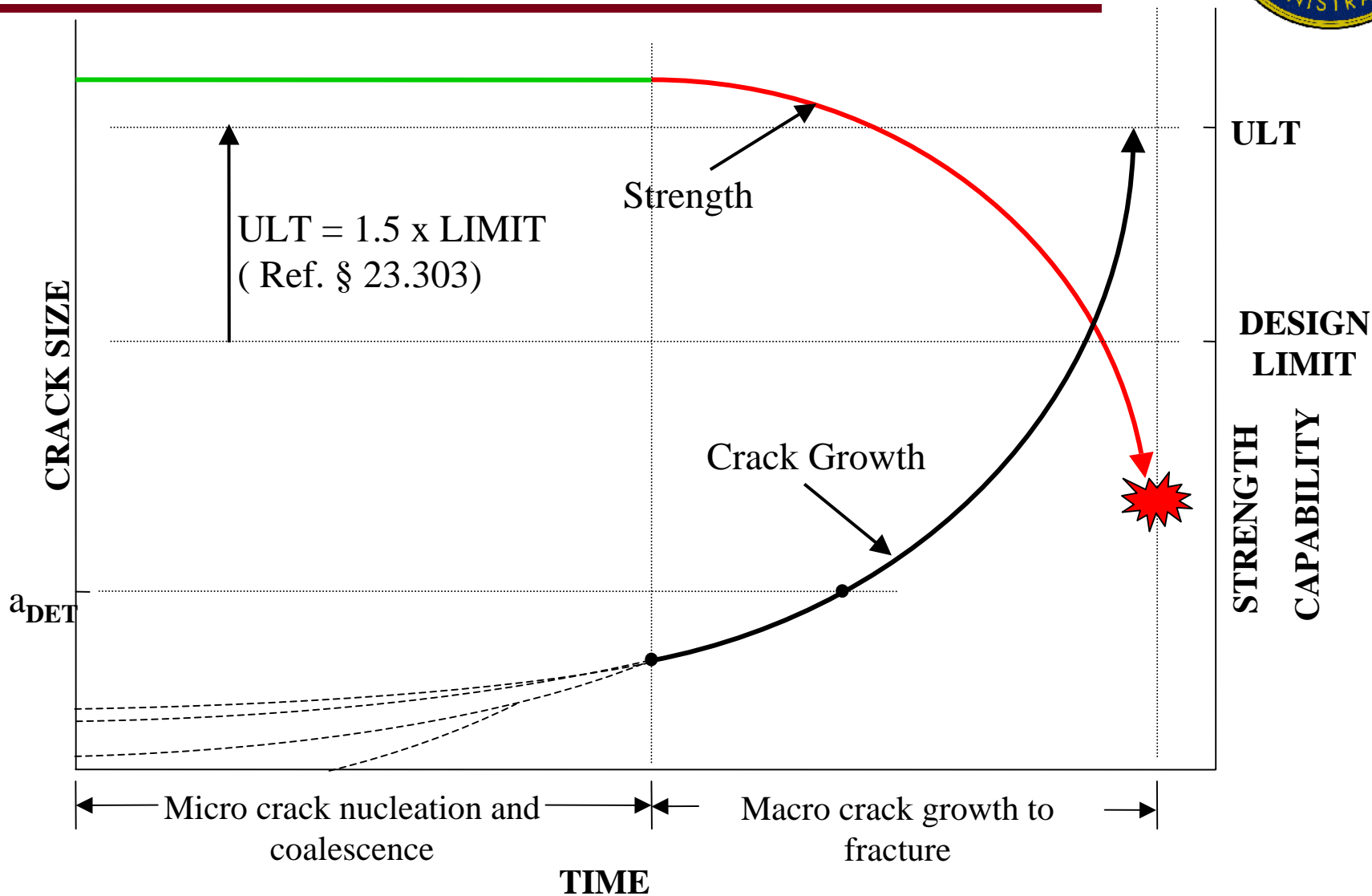


§23.305, Strength and Deformation

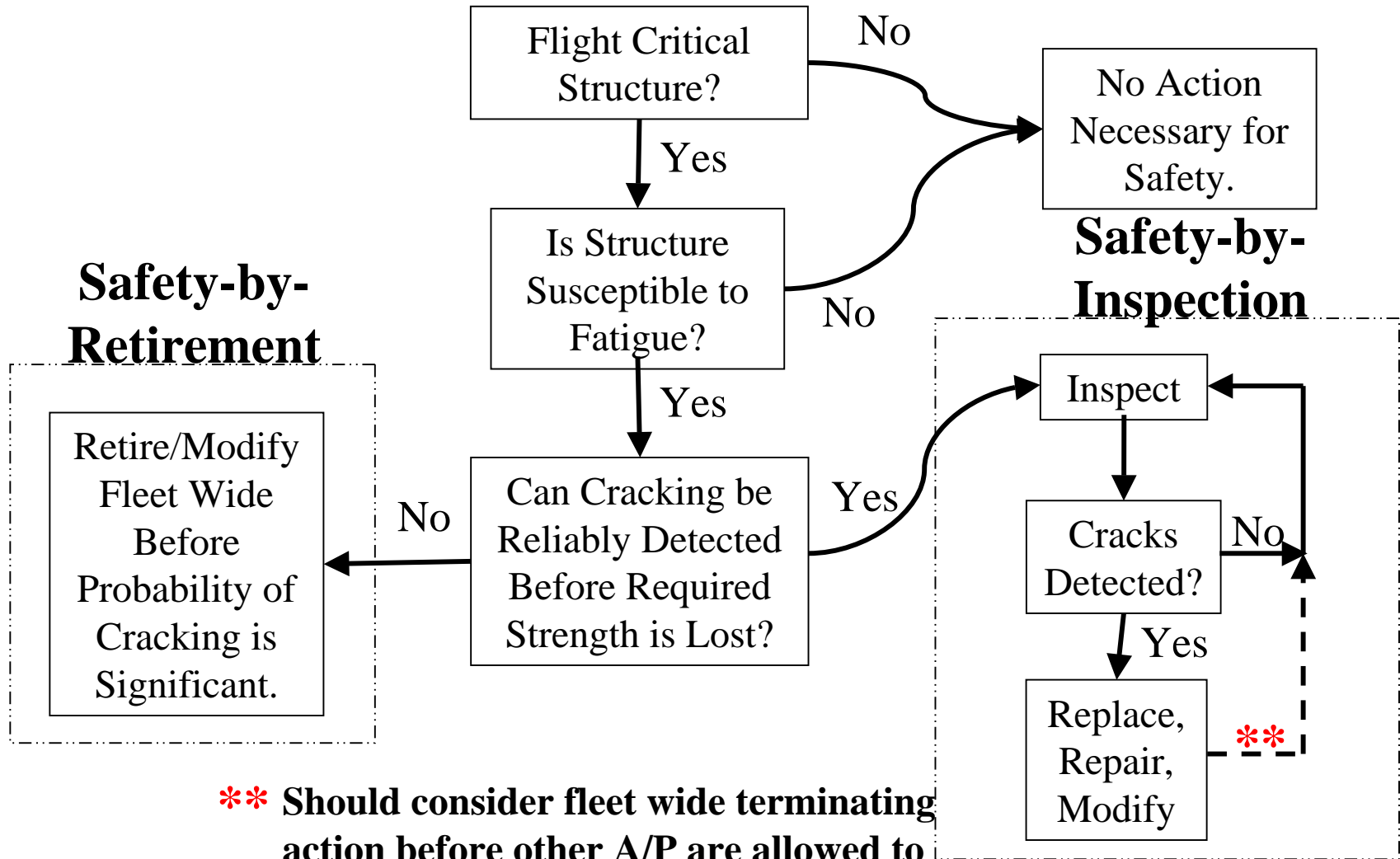
- Defines required static strength:
 - ▶ Support limit loads without detrimental or permanent deformation.
 - ▶ Support ultimate loads without failure.
- Type design requirements.
- Applicable to repair and modification.
- Applied to structure known to be cracked if considering potential operation without repair.
- No provision for relaxation based on age.



Fatigue Process

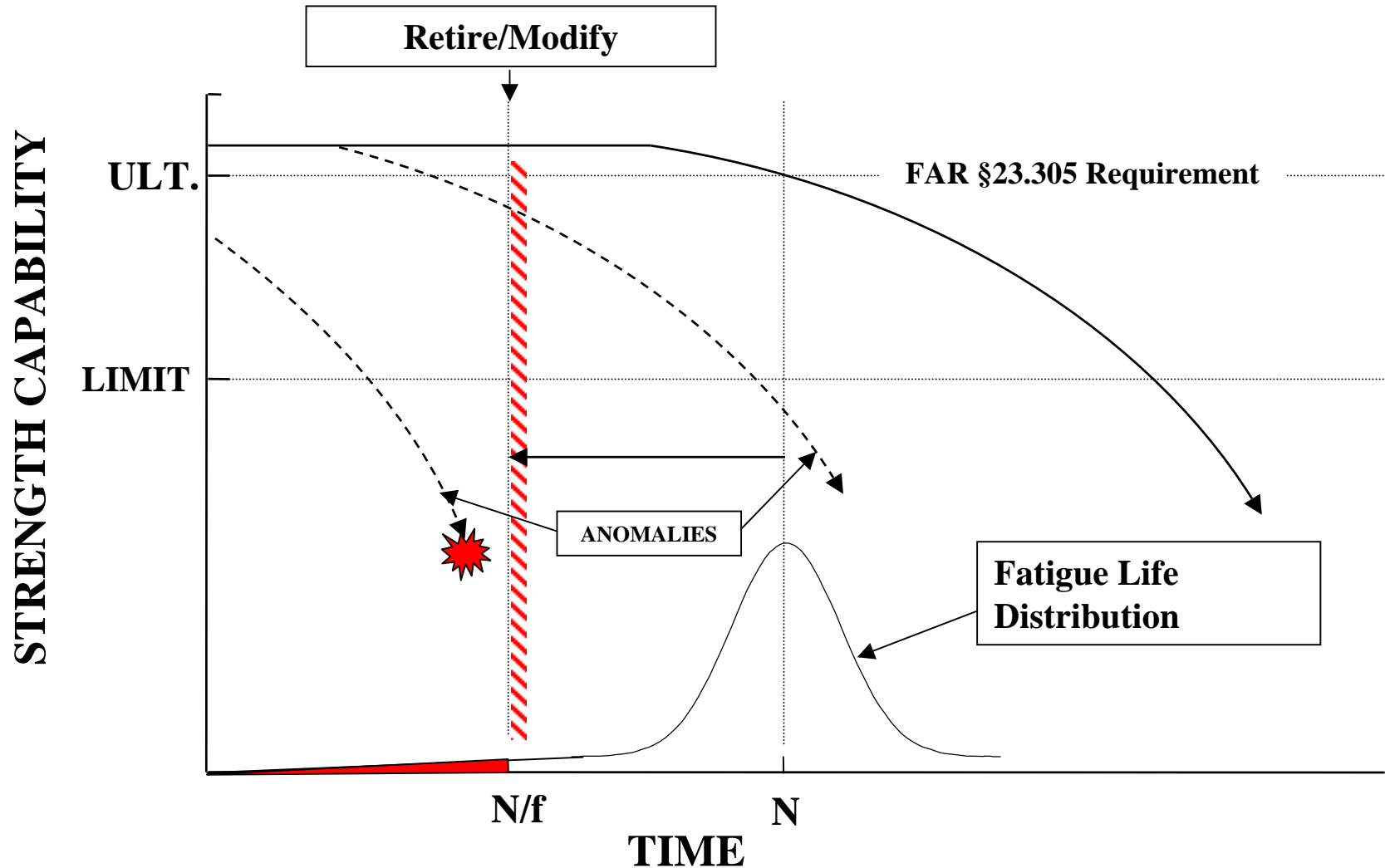


Fatigue Management Logic

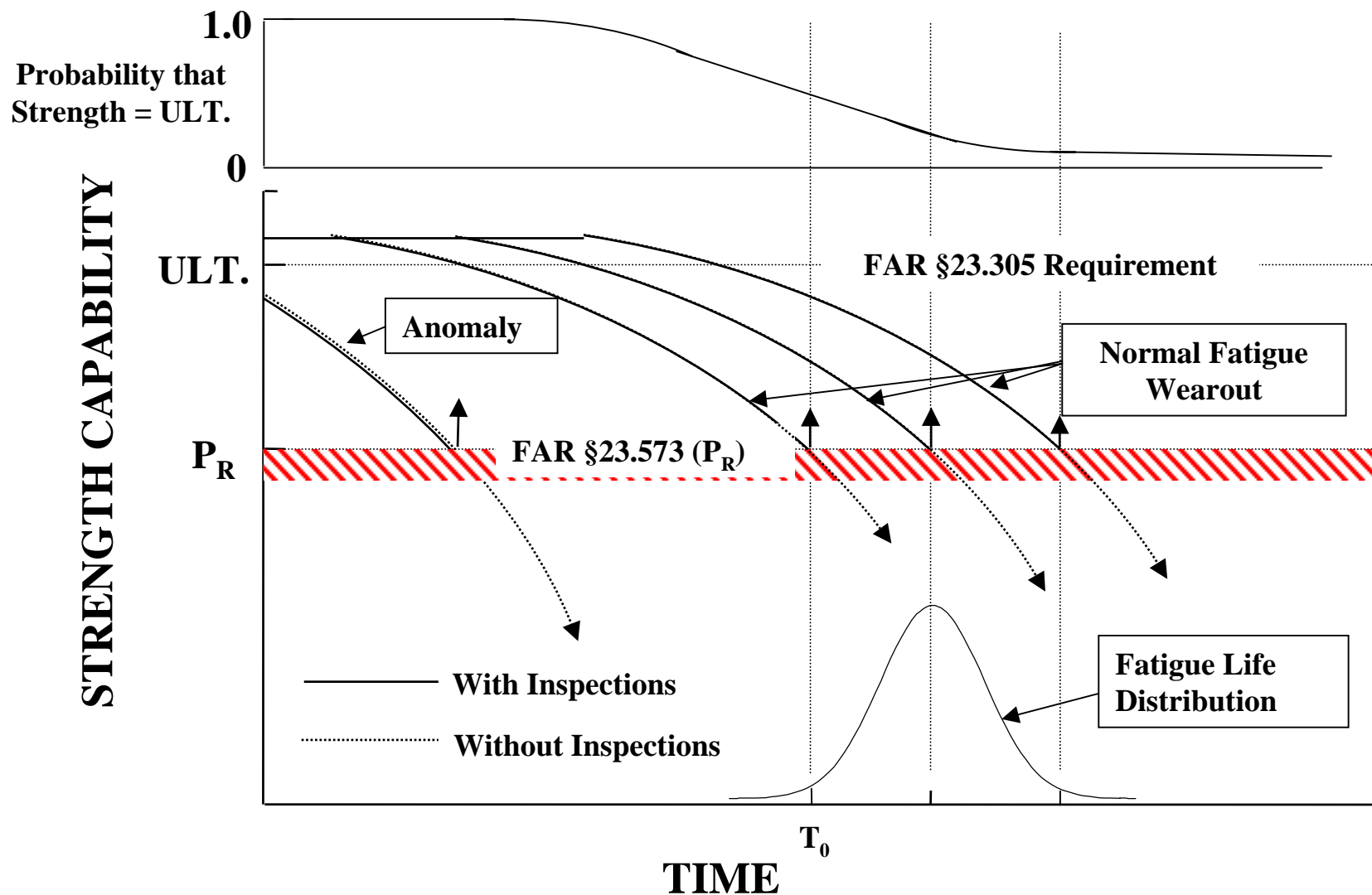


***** Should consider fleet wide terminating action before other A/P are allowed to crack.**

Application of Safety by Retirement



Safety-by-Inspection



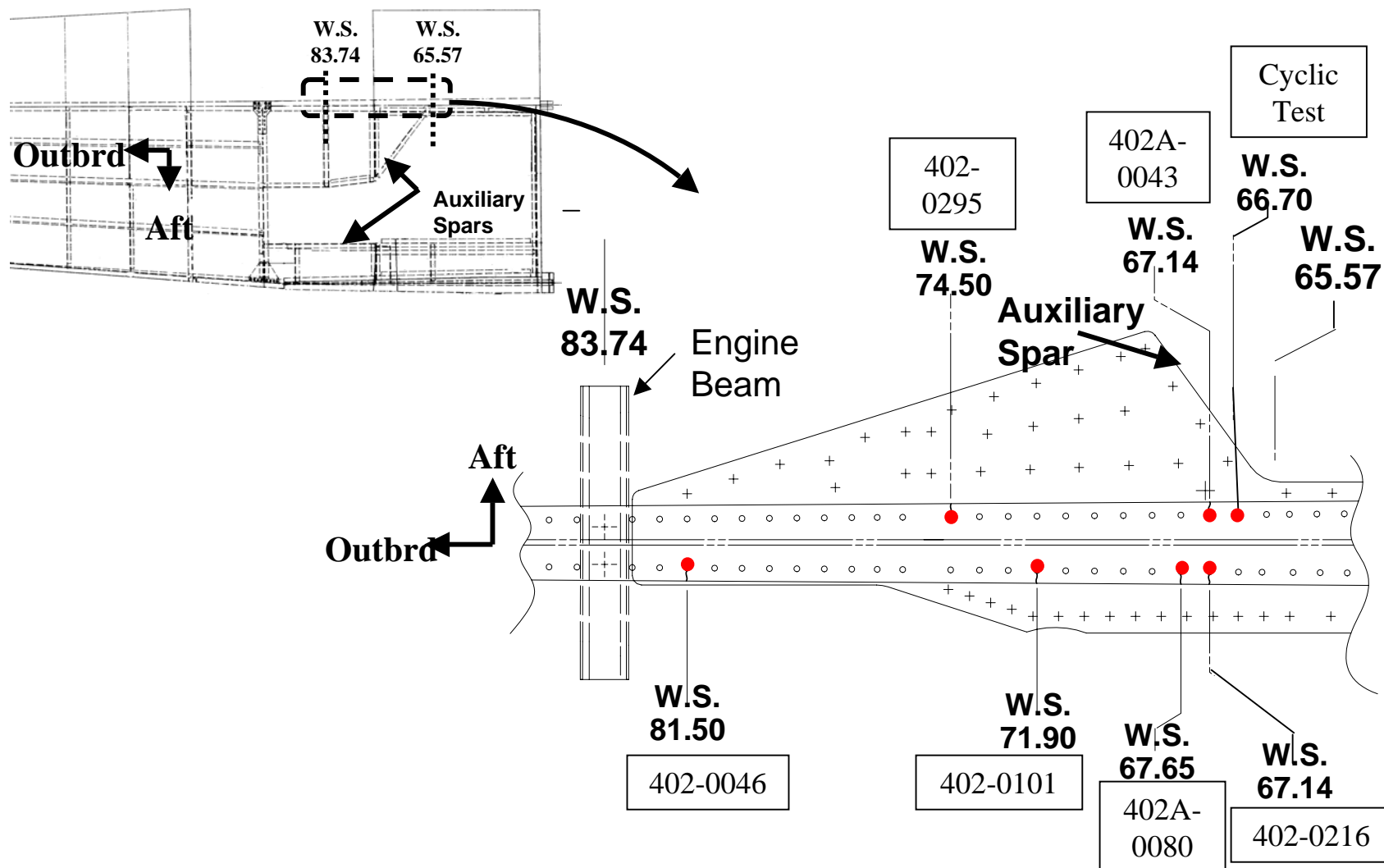


402 Fatigue Cracking Experience

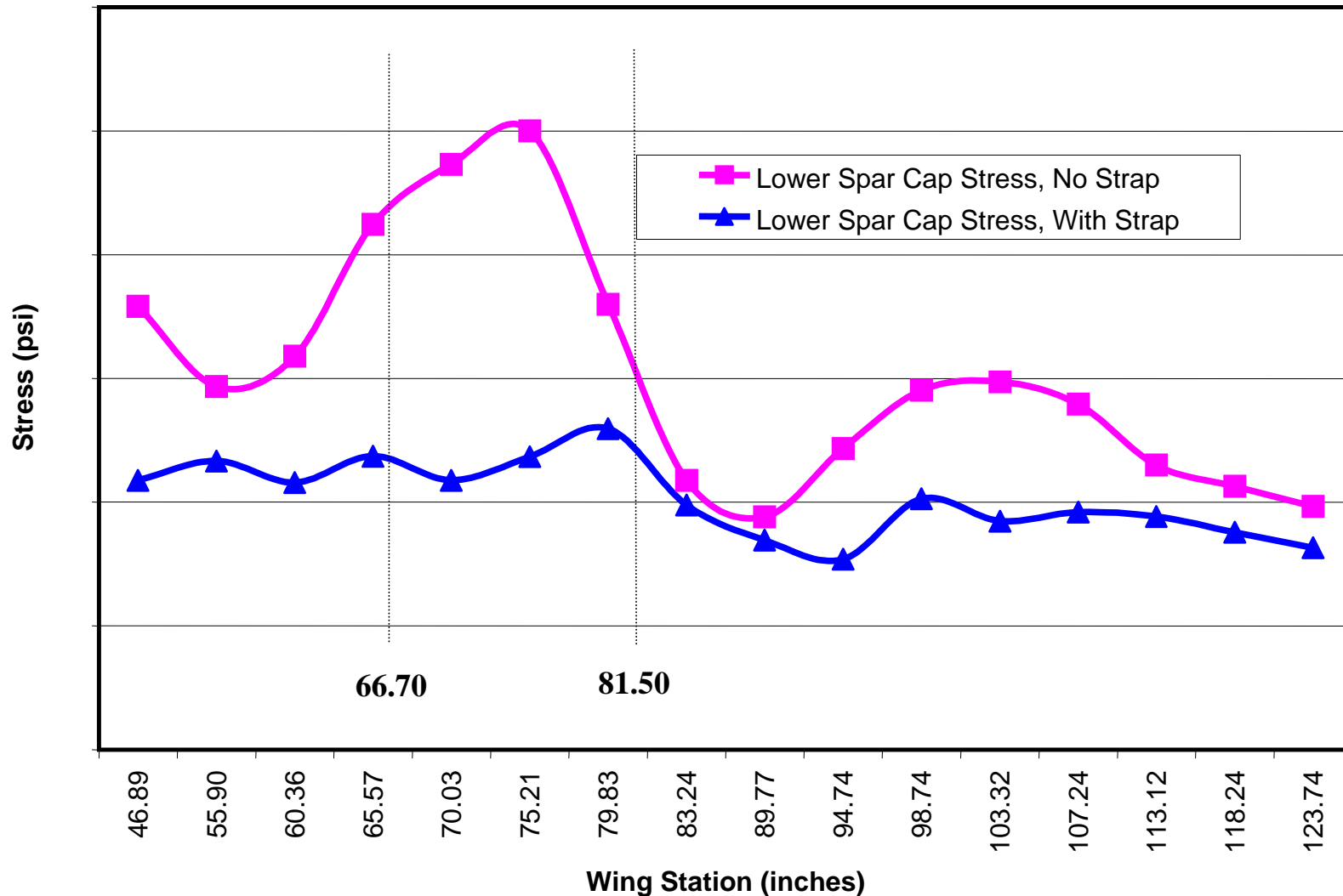
Unit	Flight Hours	Wing Station	Location	Crack Origin	Failure Mode
402-0046	8373	81.50	Fwd Flg	Fastener Hole	Complete cap failure. The airplane had an engine fire that left the cap with 50% of required tension capability after 1830 hours. – Right Wing
402-0295	8057	74.50	Aft Flg	Fastener Hole	Complete cap failure – Left Wing
402A-0043	13824	67.14	Aft Flg	Fastener Hole	.05” crack detected when evaluating new NDI equipment.
402-0101	16000	71.90	Fwd Flg	Fastener Hole	Complete cap failure – Left Wing
402A-0080	13773	67.65	Fwd Flg	Fastener Hole	Complete cap failure – Left Wing
402-0216	9012	67.14	Fwd Flg	Fastener Hole	Spar cap ligament failure – Left Wing
Cyclic Test	14,000	66.70	Aft Flg	Fastener Hole	Complete cap failure.



402 Known Cracking Locations



MODEL 402 WING MAIN SPAR LOWER SPAR STRESSES MAXIMUM POSITIVE WING BENDING LIMIT LOAD



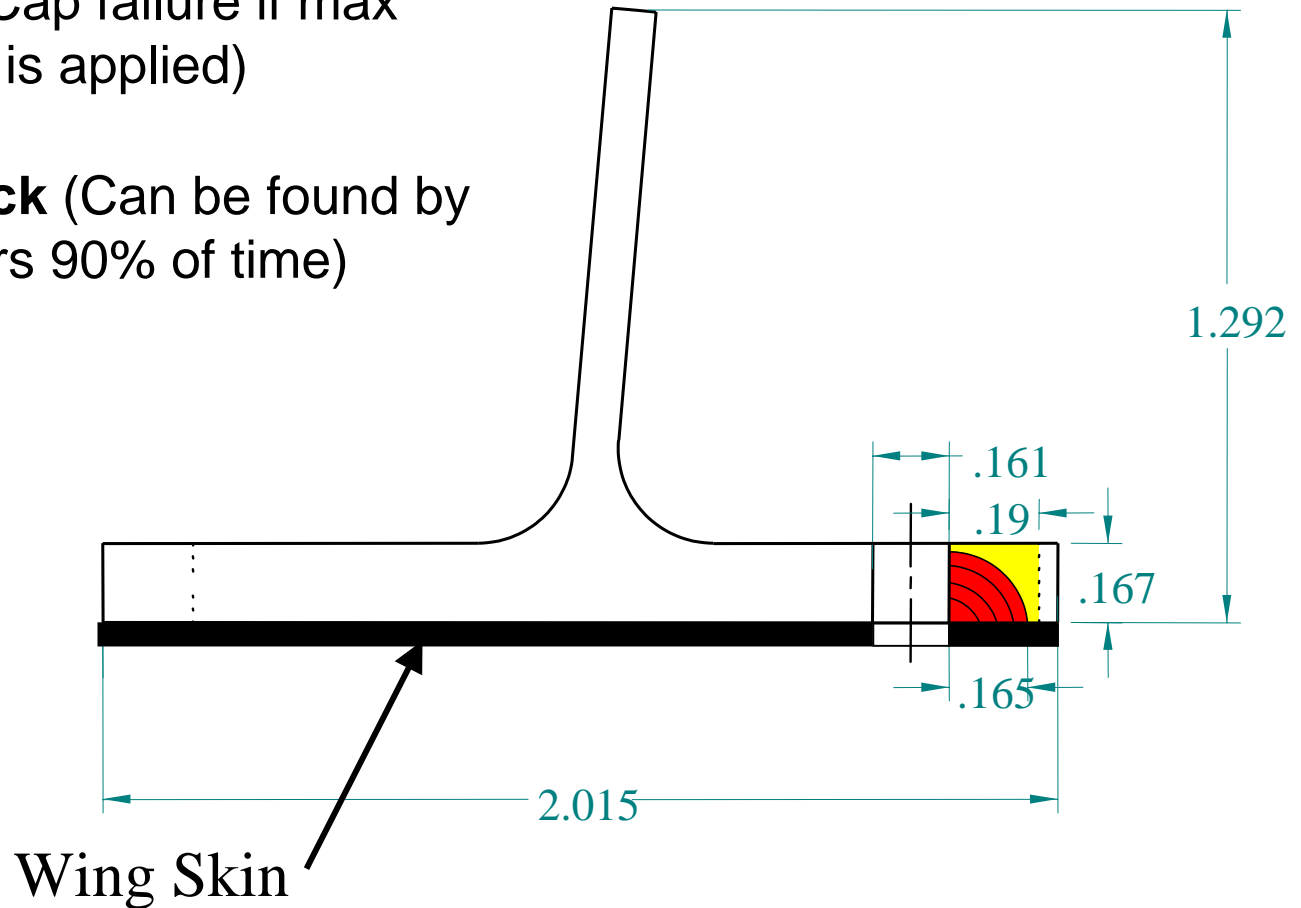
402 Critical & Detectable Crack Sizes



Critical Crack (Cap failure if max design limit load is applied)



Detectable Crack (Can be found by 95/100 inspectors 90% of time)



402 Residual Strength



- Wing strength with spar cap failed is less than **1/2** original type design strength for 401, 402, -A, -B, 411.

Summary of 402 Findings



- Sufficient service and test experience and fatigue analysis results exist to indicate that:
 - ▶ Spar cap is susceptible to fatigue cracking in a local area.
 - ▶ Without intervention fatigue cracking can be expected to occur.

Summary of 402 Findings



- Sufficient fracture mechanics analysis results exist to indicate that:
 - ▶ The crack size that could cause the cap to fail if design limit load is experienced is relatively small.
- Sufficient NDI data exist to indicate that:
 - ▶ Reliable detection of a crack before it reaches critical size may not be possible in some areas.

Summary of 402 Findings



- Sufficient analysis results exist to indicate that:
 - ▶ With the spar cap failed the wing strength capability is reduced to less than 1/2 of original type design strength (i.e. all type design strength margin is lost) for 401, 402, 402A, 402B, 411.

Corrective Action Required

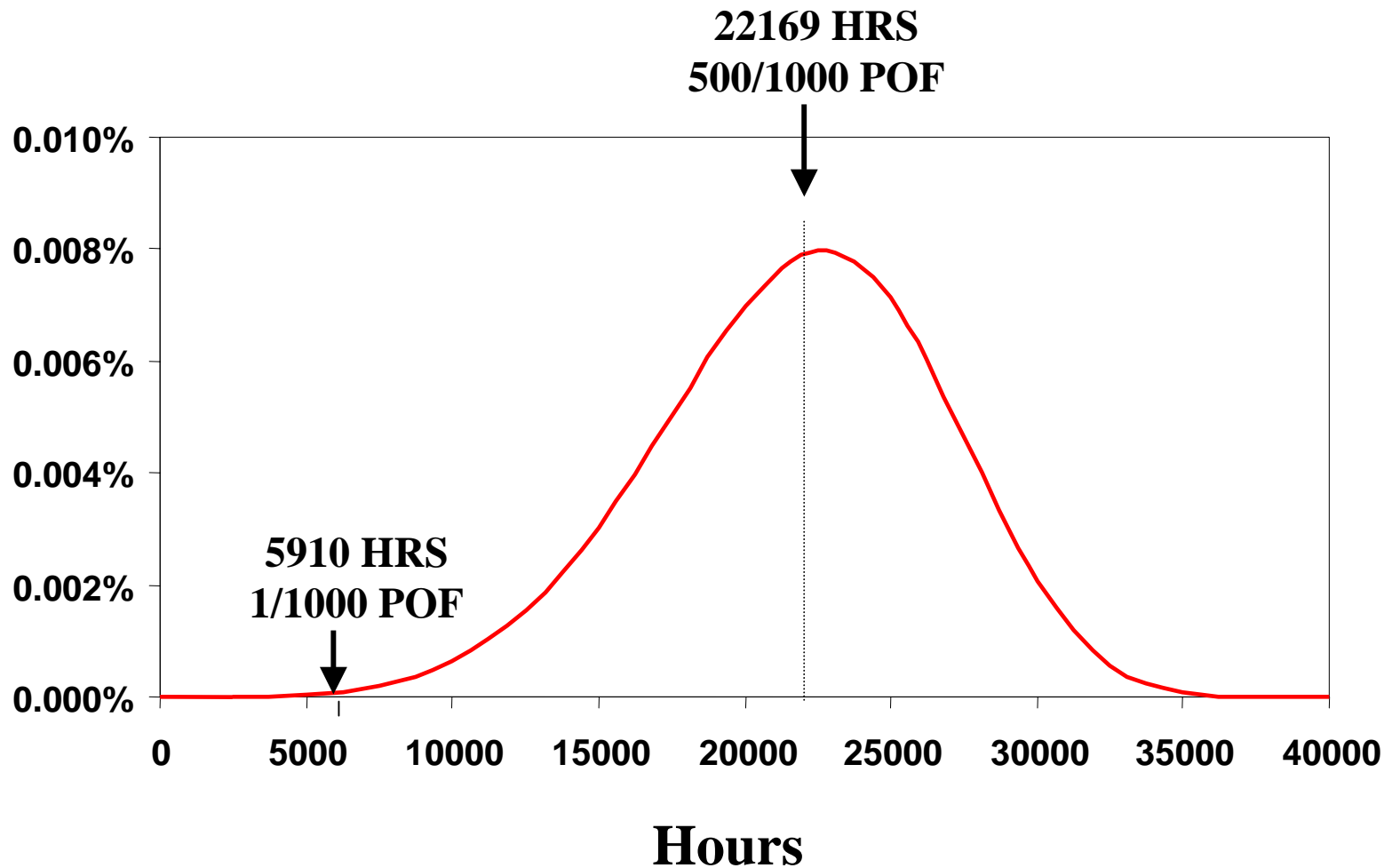


- Address the local fatigue critical area at some point in time
 - ▶ Retirement/modification required since inspection does not have high enough reliability
- Address the general lack of tolerance to damage
 - ▶ Modify design to increase tolerance

6 + 367 Distribution



Probability Density



FAA Presentation Conclusions

March 2004 Meeting



- Unsafe condition exists in all models
 - ▶ 402 test results and service experience
 - ▶ Stress analyses
 - ▶ Fatigue analyses
 - ▶ Damage tolerance analyses
 - ▶ Similarity between models

FAA Presentation Conclusions (cont'd)

March 2004 Meeting



- 2002-CE-05 AD and 2002-CE-57-AD means to address unsafe condition
 - ▶ Stress analyses
 - ▶ Fatigue analyses
 - ▶ Damage tolerance analyses
 - ▶ 402 service data evaluation
 - ▶ Similarity between models
- Alternative Means of Compliance
 - ▶ Must address local cracking
 - ▶ Must address inherent lack of tolerance to damage